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THE CHEMICAL COMPOSITION OF CEMENT PLASTER.

BY E. H. S. BAILEY, LAWRENCE.

Read before the Academy October 28, 1897.

There has been found, scattered over quite large areas in some of the central states, especially Kansas, Indian Territory, and Texas, an earthy material, which consists practically of gypsum sand, and which has been utilized for the manufacture of a material which has been called "cement plaster." This material is of light color, and when dry frequently as fine as dust, and is evidently of recent origin, deposited from water. There are often watercourses in the vicinity of the deposits; and springs of water strongly impregnated with calcium sulfate often flow from the beds. These beds cover an area of from ten to twenty acres, and vary in thickness from two to ten feet. One peculiarity of the location is that they are usually on only one side of a stream.

This material, to which we have assigned the name "gypsite," upon being examined with a microscope, is seen to consist of numerous crystals of gypsum, associated, however, with much material that seems to be amorphous in structure. As it can be readily broken up with a plow and harrow, and can be handled like ordinary dirt, being loaded upon wagons with a grader, it has been found very economical to use it for the manufacture of plaster. All expense of quarrying and grinding is thus avoided. Of course many claims are made for the superior quality of the product over the ordinary plaster of Paris, made from rock, but practical use of the material will solve the reasonableness of such claims. We have had special opportunities to examine a large number of samples of the original crude material, and of the manufactured product, in connection with some work for a report of the University Geological Survey.

COMPOSITION OF THE RAW MATERIAL.

The gypsite varies greatly in composition, even in the same area. This is due to various mixtures of clay on the one hand and of sand on the other. An expert can, by the appearance of the material, select the different grades, and mix them in such a proportion as to produce a product of the right composition. As an example of this, the following analyses may be quoted, all taken from material from the same bed, but sampled at different times by different persons. For convenience the constituents only are given here; but something will be said of the probable combinations farther on.

CONSTITUENTS.	GYPSITE BEDS.		
	No. 1.	No. 2.	No. 3.
Silica and insoluble residue	18.69	12.29	10.23
Iron and aluminum oxids.	1.21	2.27	1.12
Calcium oxid.	26.11	29.69	30.78
Magnesium oxid.43	.78	.49
Sulfuric anhydrid.	33.27	34.87	34.56
Carbon dioxid (calc.)	3.15	(det.) 3.52	(calc.) 5.67
Water	15.29	16.07	17.10
Totals	98.75	99.49	99.91

It will be noticed that the proportion of insoluble material varies considerably, and the water increases as this diminishes.

MANUFACTURE OF CEMENT PLASTER.

In the process of manufacture, the ordinary iron kettles are used, of a capacity of about eight tons of crude material. These kettles are heated by a coal fire directly on the bottom and the flame is carried around the sides in flues. Each kettle is provided with a mechanical stirrer making fifteen revolutions per minute. An excellent quality of coal is used so as to produce as hot a fire as possible. The crude material is dropped into the heated kettle gradually till there is a sufficient quantity, and as the heat is applied all the time a violent boiling, as it is called, takes place, from the evolution of the steam of the moisture in the original material and the combined water. A short time before the process is complete (which requires about three hours) there is a sudden settling of the material and the evolution of steam ceases, but this begins to boil again, and after a certain time, which can be determined by the expert laborer, the kettle is opened at the bottom and all the material is dropped in a few seconds into a storage pit. The burned cement is then sifted, and any particles too large to pass through the sieve are ground and burned again. In the process considerable dust is carried off from the kettle and in the best mills this is collected and saved.

In order to study the process of manufacture more completely, I have made analyses of the material in the process as follows:

No. 1, crude gypsite.

No. 2, the completed "cement plaster."

No. 3, dust thrown off from the material while being calcined.

No. 4, tailings from the bolting reel.

No. 5, sample of the "set" cement plaster.

Nos. 2, 3, 4 and 5 were from the same kettleful of cement, while No. 1 is a mixture of twelve samples of the crude material as it was running into the kettle.

In order to arrive more fully at the composition in this case the carbonic acid was determined by actual weight, after decomposing with hydrochloric acid, and it will be noticed that there is not a sufficient quantity to combine with the calcium and magnesium. This seems to indicate that some of the bases are in the combination with silica in the form of clay or other soluble minerals.

CONSTITUENTS.	Crude. No. 1.	Finished. No. 2.	Dust. No. 3.	Tailings. No. 4.	Set. No. 5.
Silica and insoluble residue....	12.29	14.31	13.48	22.02	12.03
Iron and aluminum oxids.....	2.27	2.16	2.33	2.23	1.62
Calcium sulfate.....	57.95	66.22	66.52	53.67	59.37
Calcium carbonate.....	8.01	9.42	6.53	12.17	8.07
Calcium oxid.....	2.12	1.85	2.56	4.70	1.89
Magnesium oxid.....	.78	.91	.59	.56	.61
Water	16.07	4.91	6.78	4.43	16.38
Totals	99.49	99.78	98.79	99.78	99.97

It is interesting, also, to notice in this connection that the set cement agrees remarkably in composition with the original crude sample. It has just about the same quantity of water that was originally present.

In the dust there is present 6.78 per cent. water, which shows that some of the material not fully calcined had been carried off from the kettles. The tailings contain more of the silica and insoluble material. This is to be expected, as those are the parts that have not so readily broken up under the influence of heat. As the heat is carefully kept below a 400° F., there seems to be little pos-

sibility that the carbon dioxide should escape, and the comparison of the first and last samples show that this is the case. The carbon dioxide in the first was 3.52 and in the last 3.55 per cent.

There is a wide variation in the per cent. of calcium and magnesium carbonates in different samples, and the positive effect of different quantities of this substance has not been ascertained. From what is known, the magnesium plays very little part in the determination of the quality of the set cement. The amount of water in the manufactured plaster seldom falls much below five per cent.; the variation being not over two per cent. when a number of analyses are compared.

Something should perhaps be said about the use of "retarders" in cement manufacture. They are especially used with the rock plasters, though occasionally, no doubt, with the cement plasters. The common opinion is that sours and sweets act as retarders, and many substances of these classes are used, such as citric acid and sorghum molasses. It is possible by the judicious use of such a retarder to delay the setting of the cement many hours, when it would normally set in a few minutes. The action of these materials seems to be to prevent the material hardening by the formation of the crystalline compound. On the other hand, there are some things that act as accelerators, and in mixing the plasters they must be rigidly excluded. For instance, if a plaster is mixed in a vessel which contained some plaster that has previously set, the setting is very much accelerated. This would very readily remind one of the production of sudden crystallization in saturated solutions by bringing into them crystals of the same material. A number of other problems in connection with the specific gravity of the material, the amount of water that should be left in the manufactured product, and similar topics, remain to be investigated.

ON THE OCCURRENCE OF NITRATES IN WELL-WATERS.

BY E. H. S. BAILEY, LAWRENCE.

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It is a well-known fact that the ammonia of the air, as well as the small quantity of nitrates and nitrites therein contained, is washed into the soil by the rains, and this water there comes in contact with the organic matter of the soil, and oxidation takes place. This organic matter is first converted by the processes of decay into ammonia, and this in turn changes to nitrites and finally to nitrates, in which latter form it is available to aid in sustaining plant life.

The process of "nitrification," as it is called, may go on in surface-waters, as in ponds and streams, and is carried on very extensively in the upper layers of a loose, porous soil, where the oxygen of the air has an opportunity to assist.

This whole matter has been very extensively studied, within the past ten years, in its applications to agriculture, and also in its applications to the impurities of water and the purification of sewage. The admirable reports of the Massachusetts Board of Health, especially for 1890, on the purification of water and sewage, show the very extensive experiments which have been carried out, and the results of these researches, which have become almost classic. There has been a growing belief in the importance of "bacteria" in producing the change formerly ascribed to simple chemical oxidation. Although great difficulty has been experienced in isolating and cultivating the specific bacteria that are necessary to produce the change, yet the latest researches show that this can be done, and that water that has been sterilized can be treated with ammonia